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- ² A. A. LUMSDAINE. 'Experimental Research on Instructional Devices and Materials'. *Training Research and Education* (edited by R. Glaser). University of Pittsburgh Press, p. 249 (1962).
- ³ H. E. PALMER and H. V. REDMAN. *This Language-Learning Business*. Oxford University Press reprint, p. 3 et seq. (1969).
- ⁴ S. SPAULDING. 'Technology in Education: Past, Present and Future'. *International Conference: 'Programmed Instruction and Teaching Machines'* (edited by A. Bianchéri et al.). Paedagogische Arbeitsstelle und Sekretariat Paedagogisches Zentrum, Berlin, p. 145 (1964).
- ⁵ L. C. TWYFORD. 'Research Abstracts'. *AV Communication Review* 15, 2, p. 226 (1967).
- ⁶ WALTHER ZIFREUND, 'Ueber den Zusammenhang von Programmierter Instruktion, Unterrichtstechnologie und Unterrichtsforschung' ('On the Relationship between Programmed Instruction, Educational Technology, and Educational Research'). *Programmiertes lernen und programmierter unterricht*, 6, 1, p. 2 et seq. (1969).

To round-up the discussion on the usefulness of the 'Systems Approach' to Education and Industrial Training, we asked an eminent personality on the British educational scene to read the preceding fine contributions and evaluate this new concept for education.

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The Systems Approach to Education: A Practical Viewpoint

I. D. S. Beer, Headmaster of Lancing College

The purpose of the foregoing articles is to consider a specific approach to education: a systems approach. A school system consists basically of a collection of individuals connected together through the community. The system may be the entire school, the common room, one class, one class plus its teacher, one pupil plus one teacher, etc. The number and types of systems within a school are many, and because education deals with the brains and minds of individuals, it is dealing with the complex probabilistic system in every person and their complex probabilistic inter-relations. It is an environment in which control is apparent, and, therefore, well suited to a cybernetic study using a systems approach.

If a systems approach requires precisely defined and measurable objectives, then it can be used to control the imparting of factual information, which is easy to measure. Two of the objectives in the Continuation High School (Jack E. Bratten, p. 17) were to reduce absenteeism and to improve instruction; both these objectives are easily defined and measurable, but, in educational terms, are of a low order. The objectives suggested by A. Daniels (p. 23)—the enrichment of the mind, the development of personality, self expression and academic attainment—are more open-ended objectives and far less easy to measure. To consider encouragement of ethics, aesthetics and religion in precisely defined and measurable objectives

would be to destroy the very nature of them as intellectual pursuits; whilst to include imagination and sensitivity in a list of this kind would be dangerous. Bratten does emphasise that 'the systems approach seeks to view a particular educational system as only one of a large set of possible ways to achieve educational objectives' but there 'is a loss of freedom of staff personnel to independently select and change objectives'. I would wish to use the discipline of systems approach to increase the flexibility within the system rather than create rigidity, and it is apparent to me that there needs to be more openness in the approach whilst retaining the control that a systems approach to communications can bring.

A system of one teacher and one pupil

There are a vast number of different types of system within a school community, but as the most important aspect of any school concerns the inter-personal relationships between human beings it is relevant to analyse the system between one teacher and one pupil.

A teacher faced with one pupil probably has two objectives: one short-term objective which is either goal seeking or growth of ideas, and one long-term which concerns the development of the child as a whole personality. The short-term objective is, therefore, instructional in the way of imparting knowledge, or stimulating in the way of developing ideas.

Instructional. The teacher is attempting to give information in such a way that the individual will understand so that it is remembered, and can be recalled to help with a more complex stage of information imparting. In this situation the teacher, by his own output, creates for the pupil an input of information received by one or more sense organs. The pupil, on receiving the input, goes through a series of complex probabilistic reactions in the nervous system and produces his own output which acts as a feedback to the teacher. As the teacher is attempting to help his pupil to seek a definite goal, the feedback will be negative (R. H. Anderton, Fig. 2, p. 7), and the pupil will quickly, or slowly, reach this goal. As there is only an interaction of two individuals, and assuming the teacher is sympathetic, the goal will be reached efficiently.

Résumé

Les différents groupes pédagogiques que l'on trouve dans les écoles offrent par leur variété et leur complexité les conditions nécessaires à l'emploi de la cybernétique basée sur le systems approach (emploi combiné des moyens).

Les résultats tangibles obtenus par le systems approach sont faciles à vérifier: réduction de l'absentéisme scolaire et amélioration de l'enseignement, tandis que d'autres, tels que le développement mental et caractériel, le sont beaucoup moins.

Dans un groupe formé d'un éducateur et d'un seul élève, le but de l'éducateur est:

- (1) D'instruire: la rétroaction de l'élève permet de vérifier ce qu'il a retenu et ceci, joint au contact personnel, permet d'atteindre efficacement le but que l'on s'était fixé.
- (2) De développer les idées en donnant à l'élève la possibilité de contester les opinions de l'éducateur en se basant sur son expérience passée.

Lorsqu'un enseignant se trouve en présence d'un groupe de trente élèves il devrait pouvoir communiquer personnellement avec chacun d'eux. Mais comme il ne peut prêter attention qu'à un seul élève à la fois, la rétroaction des autres élèves se trouve perdue. On pourrait remédier à cette situation si l'on disposait d'écoles où les élèves puissent travailler par petits groupes et se servir de machines qui enregistrent leurs rétroactions individuelles. Il se peut qu'une méthode analogue au laboratoire de langues puisse être utilisée permettant à chaque élève de communiquer avec le professeur sans déranger l'ensemble de la classe.

Le systems approach permet d'atteindre plus efficacement les buts pédagogiques à court terme, c'est à dire l'instruction des élèves. L'éducateur est ainsi libéré de certaines tâches et peut s'occuper plus à fond des buts à long terme: le développement émotif et mental de ses élèves.

L'emploi de ces méthodes nécessiterait, cependant, plus d'éducateurs et plus d'argent.

If the teacher in this situation were a programmed instructional book, the feedback would be more rigid, and, depending on the pupil, the goal may be achieved more or less quickly. If the teacher were a machine, linked to a computer, so that reaction time, etc., would be measured, the straightforward instruction might well be achieved more quickly.

Growth of ideas. The other short-term objective is more difficult to measure but the systems model is still a simple one (R. H.

Anderton, Fig. 2, p. 7). The teacher creates an output which encourages the pupil to feel free to diverge so that imagination is stimulated and ideas are created by random association of past facts. This reaction of the pupil becomes positive feedback and the interplay of ideas between teacher and pupil creates a plethora of growth in the minds of both. Neither knows how the black box of the brain is functioning; the interplay of ideas and facts is stimulating and invigorating. The objective is clear in this system, but the objective is not easily measured, except subjectively. There is, of course, no correct answer unless a constrain has been applied on the system which makes the final idea one which can be tested by experiment. This would be true of the growth of ideas, and interplay of facts, in solving a scientific objective as against the development of an art form.

The use of educational hardware may make instructional teaching more efficient, but it may preclude any real understanding of the long-term objective. Although a good teacher without any systems approach may well achieve the immediate goal less quickly, some vital long-term influences on personality will have taken place. The teacher will have had the opportunity to consider the instruction being given in relation to the development of the whole child, and this in itself may affect the way in which the instruction is given. Moreover, should there be physical or emotional stresses in the pupil, the teacher may be able to ease the way to achieving the short-term goal by understanding these problems.

A system of one teacher and thirty pupils

This system is at once complicated by the vast number of different pathways of communication. There are, at once, thirty channels of communication open between the pupils and the teacher and the teacher is faced with the possibility of thirty different channels of communication although probably having to assume that one will do for all. A brief analysis of this system will make the constraints apparent.

The teacher creates an output related, he believes, to the past experience of his pupils. Each pupil receives the same input from the teacher, and they all want to create a feedback

Zusammenfassung: Ein System Approach zum Unterricht: ein praktischer Gesichtspunkt

In den vorhergehenden Artikeln wird immer wieder betont, dass ein unzweideutig beschriebenes Lehrziel, dass gemessen werden kann, den Angelpunkt eines Lehrsystems darstellt. Dies führt aber zu einer gewissen Starrheit, wo doch in der Bildung eine grosse open-endedness wünschenswert ist.

Im Unterricht bestehen zwei Hauptziele: 1. das engere Ziel, den Schüler in einem Gegenstand zu instruieren. 2. das weitere Ziel, die Ganzheit der Persönlichkeit des Kindes zu entwickeln.

In der Situation: Ein Lehrer—ein Schüler wird der Lehrer vielleicht ohne technologische hardware langsamer zum Ziele kommen, er kann aber seinen Einfluss auf die Charakterentwicklung gleichzeitig ausüben. Auch im Falle von emotionalen Schwierigkeiten kann er durch sein Verständnis das Erreichen des Instruktionszieles erleichtern.

Im Falle: Ein Lehrer—30 Schüler wird das System durch die grosse Anzahl von Kommunikationsgeräuschen erschwert. Beide, oben erwähnten Ziele leiden darunter, dass der Lehrer nicht wissen kann, was in den verschiedenen "black boxes" vorgeht, er kann nur raten, aber keineswegs messen.

Der Autor schlägt vor, dass in der Schulklassensituation der System Approach eine Umwälzung hervorbringen kann. Ein architektonisch flexibler Schulbau wird es dem Lehrer ermöglichen, mit kleinen Gruppen zu arbeiten, die wohl von der Hauptgruppe getrennt, aber doch vom Lehrer kontrolliert werden können. Lehrmaschinen können eingesetzt werden, denn solche Einrichtungen reagieren mit Hilfe von individueller Rückmeldung. Leider sind aber unsere Lehrer im Gebrauche beider Einrichtungen nicht geübt und es besteht die Gefahr, dass die technischen Mittel brachliegen.

Der Ausweg ist ein elektronisches Klassenzimmer. Hier kann der Lehrer aufgrund der elektronisch vermittelten Rückmeldungen sein Unterrichtsvorgehen dauernd ändern und den Schülern anpassen.

Die Konsequenzen der system-theoretischen Erwägungen im Erziehungssystem deuten auf sehr grosse unternehmerische Reorganisationen hin. Solche Entwicklungen hängen immer von Menschen und Geld ab aber wir müssen unbedingt im Auge behalten, dass die Aufgabe der Erziehung ist, nicht erfolgreiche Menschen zu produzieren, aber wertvolle Menschen.

to him or her. The teacher cannot allow this all at once, so selects one pupil to produce his personal feedback. This information is, of course, communicated to all the other twenty

nine pupils, many of whom will wish to react: some positively—‘that is my problem too, sir’, others negatively—‘this is a waste of time, as I understand already’. At once there is possible confusion; sometimes there is actual confusion and the teacher imposes control by telling one and all to keep quiet, thus destroying the vital feedback loop. What else is the poor teacher to do? He answers the question of one or two, asks whether all understand and goes on. The fact that some do not understand, but have given up, or that some are already two pages ahead of the teacher, is information outside his control. The teacher goes on as best he may, and when he tests to measure the short-term goal-seeking objective is happy to find the spread of marks showing, apparently, that some of the pupils are brighter than others. The fact that the so-called less bright might have achieved the highest score had they participated better in the feedback loop worries few of us. However, it is worth pointing out that some teachers are humbled when a pupil is moved from the bottom of the top set to the top of the second set only to find that he then achieves far more than ever before: one of the reasons for this being that he is now simply joining in a communication with the teacher that has direct bearing on his previous experience. He is participating in a system under control operating through feedback.

The short-term objective of the growth of ideas suffers from the same problem, there are too many channels of interrelated communications and the controller (teacher) is not aware of the situation in any black box (brain) which is not creating an output. A good teacher attempts to involve everyone, but there is no way of measuring the situation he is handling. It is very inefficient.

The long-term objective is almost, but not quite, as difficult. The personality of the good teacher can influence all thirty pupils simultaneously, but the compassionate handling by the teacher of one pupil who has particular emotional or physical difficulties is not so easy when he or she is surrounded by twenty-nine contemporaries who may have to be made to view the situation as normal.

It is in this classroom situation that a systems

approach could well revolutionise our teaching. At present the teacher can be assisted by:

1. Untraditional buildings, which enable small groups of children to be separated from the main class, yet be kept under control.
2. Educational hardware, such as machines, which will treat each pupil as an individual because the machines react *only* to the feedback created by the individual pupil.

The problem with both these aids is that the teachers must be equipped to handle the hardware or use the building to its best, and few teachers have been trained to do this. One of the urgent needs for the future is for teachers trained in educational technology, or else all the technical help will have rusted or shorted itself in the cupboard.

However, Stafford Beer has suggested it may be possible to create a system which would enable individual students in classes to record a simple type of feedback to the teacher without disturbing the rest of the pupils, or upsetting the output from the teacher. The effect would be to create a silent path of communication to the teacher which would allow him to see which pupils were understanding him, which were not, which wished to be involved and which had literally switched off. The teacher would then be in a position constantly to alter his output according to the continuing feedback he was receiving. If this system of communication were created electronically by lights on the teacher's panel and switches on the pupils' desks, it would not be to different from the situation at present available in some language laboratories.

Implications

The implications which follow from considering a systems approach to traditional educational matters are so great as to alter the training of teachers, the architecture of school buildings, the organisation of the time-table and thus the administration of the school. In my view this revolution will stem from the re-organisation within one classroom, and the re-thinking will move outwards like the ripples on a pond from the point of original disturbance.